US005721903A

United States Patent [19]

Anand et al.

[11] Patent Number: 5,721,903

[45] Date of Patent: Feb. 24, 1998

[54] **SYSTEM AND METHOD FOR GENERATING REPORTS FROM A COMPUTER DATABASE**

[75] Inventors: **Tejwansh S. Anand**, Roswell, Ga.; **Michael A. Georgantos**, San Diego, Calif.; **Yih-Shiuan Hu**, Alpharetta; **James F. Knutson**, Roswell, both of Ga.; **Drew T. Lettington**; **Marshall P. Lindsay**, both of San Diego, Calif.; **Alan J. Meyer**, Riverside, Calif.; **Kenneth W. O'Flaherty**, Del Mar, Calif.; **Richard N. Schubert**, San Diego, Calif.; **Peter G. Selfridge**, Watchung, NJ.

[73] Assignee: **NCR Corporation**, Dayton, Ohio

[21] Appl. No.: **545,048**

[22] Filed: **Oct. 12, 1995**

[51] **Int. Cl.**[6] **G06F 17/30**

[52] **U.S. Cl.** **395/605**; 395/601; 395/603; 395/613

[58] **Field of Search** 395/601, 602, 395/603, 604, 613, 605, 611

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,088,052	2/1992	Spielman et al.	395/158
5,404,506	4/1995	Fujisawa et al.	395/600
5,414,838	5/1995	Kolton et al.	395/600
5,455,945	10/1995	VanderDrift	395/600
5,471,611	11/1995	McGregor	395/600
5,537,590	7/1996	Amado	395/600
5,544,298	8/1996	Kanavy et al.	395/155

OTHER PUBLICATIONS

Korth and Silberschatz, "Database System Concepts" 2/E, McGraw-Hill Inc., pp. 97–98 Dec. 1991.

Primary Examiner—Thomas G. Black
Assistant Examiner—Donald Min
Attorney, Agent, or Firm—Paul W. Martin

[57] **ABSTRACT**

A system and method for generating a report for a user which allows the user to make decisions, without requiring the user to understand or interpret data itself. A database management program executed by a server within a system for generating the report for the user includes a first subsystem for translating user requests for data, for generating dimensional queries for retrieving data from a database, and for processing user modifications to data types used in generating the report. A second subsystem coupled to the first subsystem reads data from the database, creates the data types, creates a mapping of the data types to the data, uses the mapping to translate user-initiated dimensional queries received from the first subsystem into Structured Query Language (SQL), and returns query results to the first subsystem. A third subsystem creates the report at a predetermined time.

4 Claims, 12 Drawing Sheets

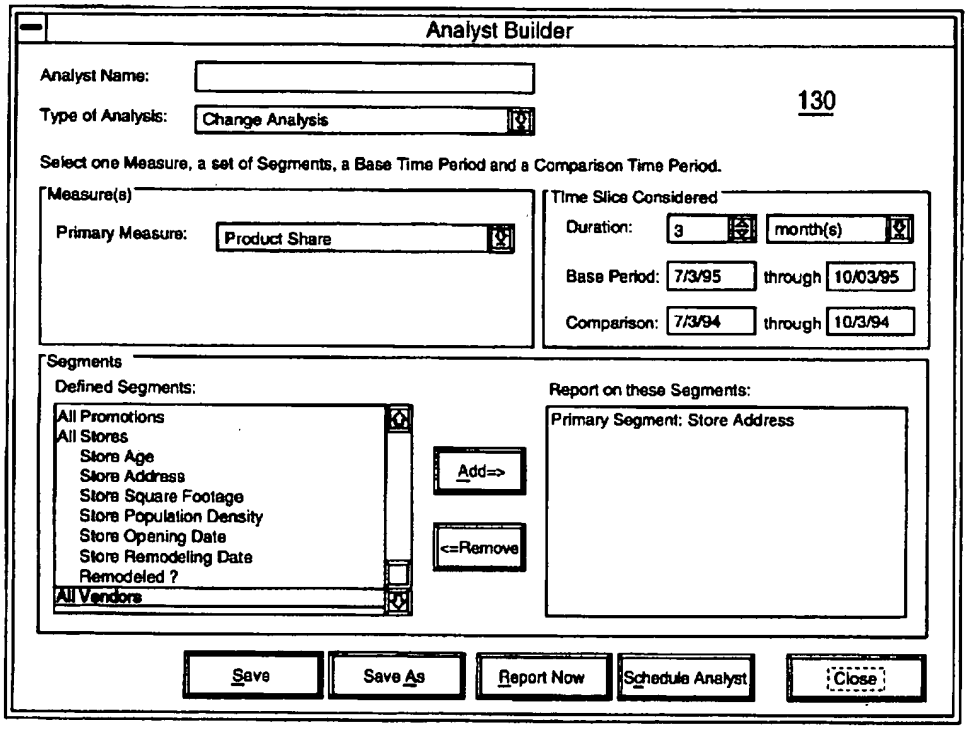
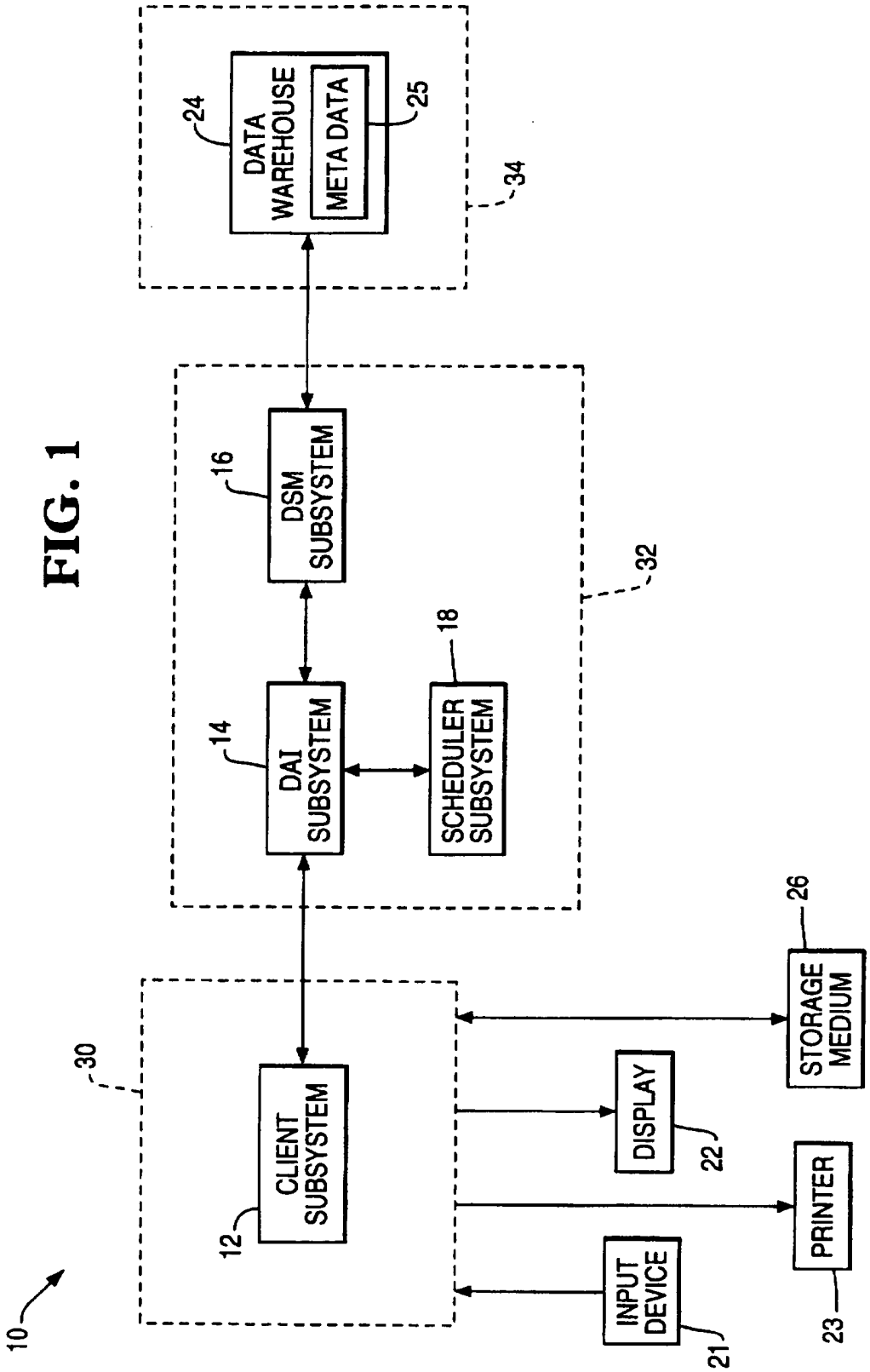


FIG. 1


DATA WAREHOUSE
META DATA
24
25
34
DSM SUBSYSTEM
16
32
DAI SUBSYSTEM
14
SCHEDULER SUBSYSTEM
18
CLIENT SUBSYSTEM
12
30
10
STORAGE MEDIUM
26
DISPLAY
22
PRINTER
23
INPUT DEVICE
21

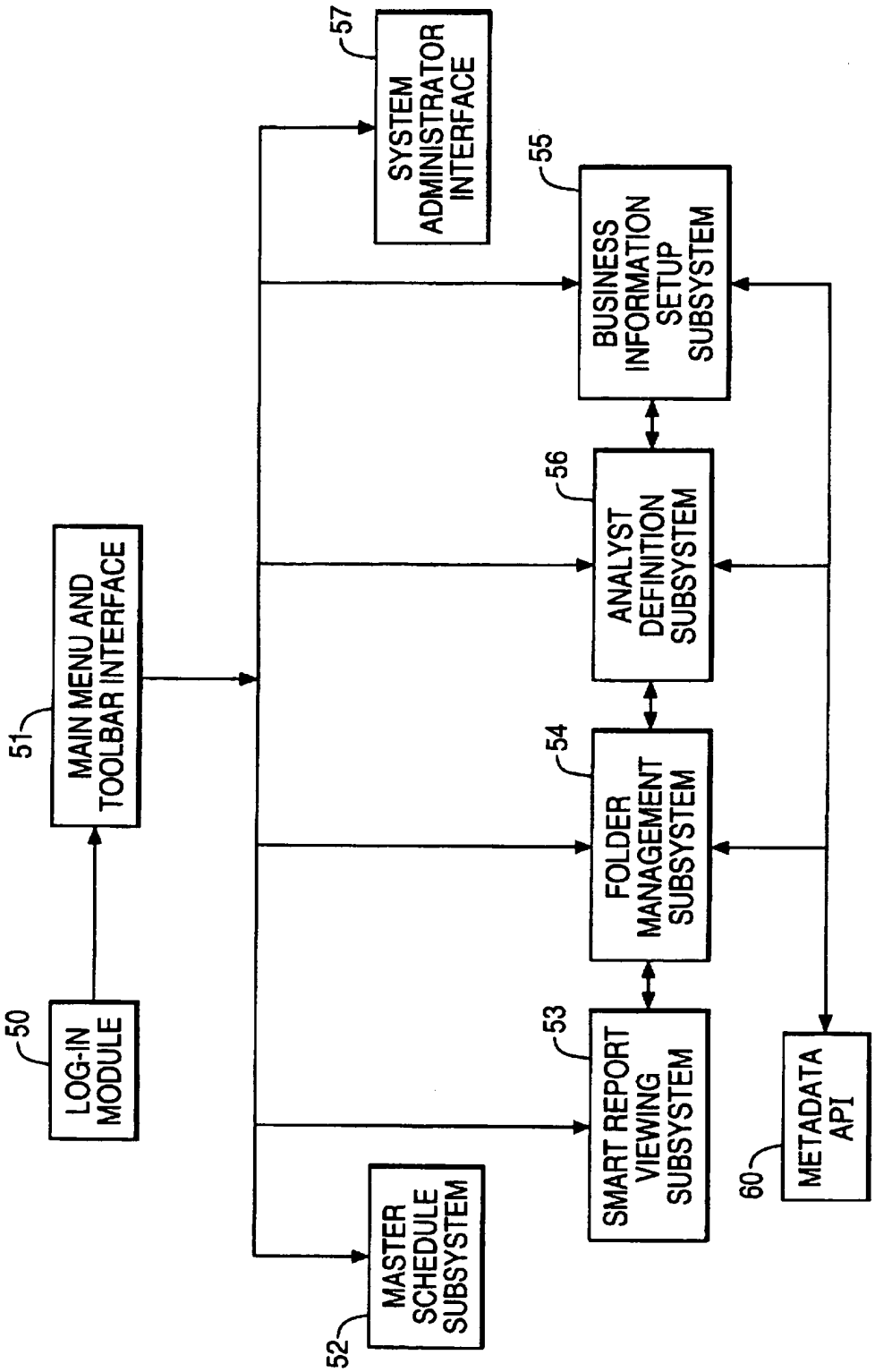

57
SYSTEM ADMINISTRATOR INTERFACE
55
BUSINESS INFORMATION SETUP SUBSYSTEM
56
ANALYST DEFINITION SUBSYSTEM
54
FOLDER MANAGEMENT SUBSYSTEM
53
SMART REPORT VIEWING SUBSYSTEM
60
METADATA API
51
MAIN MENU AND TOOLBAR INTERFACE
50
LOG-IN MODULE
52
MASTER SCHEDULE SUBSYSTEM

FIG. 2

FIG. 3

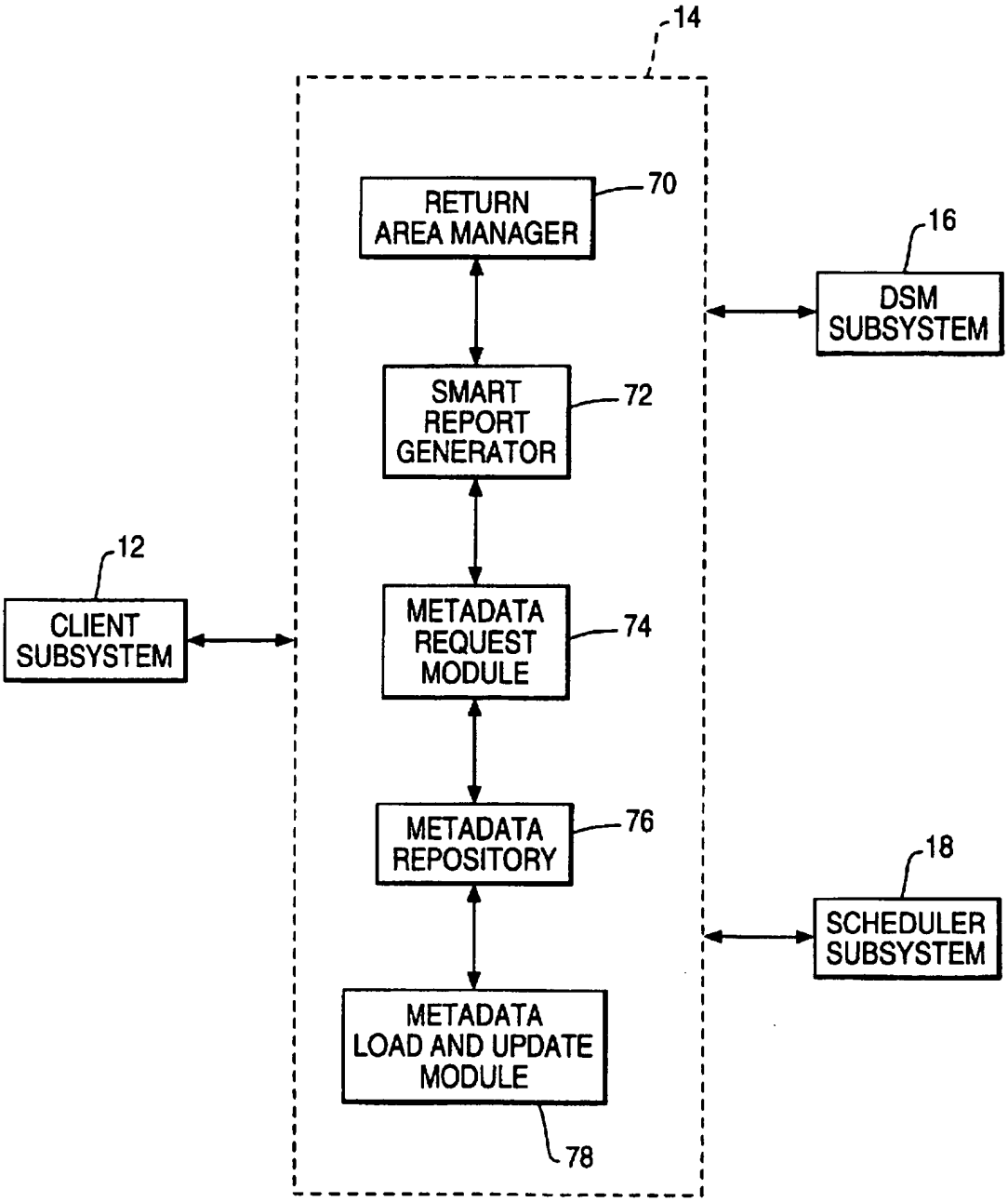

14
RETURN AREA MANAGER
70
16
DSM SUBSYSTEM
SMART REPORT GENERATOR
72
12
CLIENT SUBSYSTEM
METADATA REQUEST MODULE
74
METADATA REPOSITORY
76
18
SCHEDULER SUBSYSTEM
METADATA LOAD AND UPDATE MODULE
78

FIG. 4

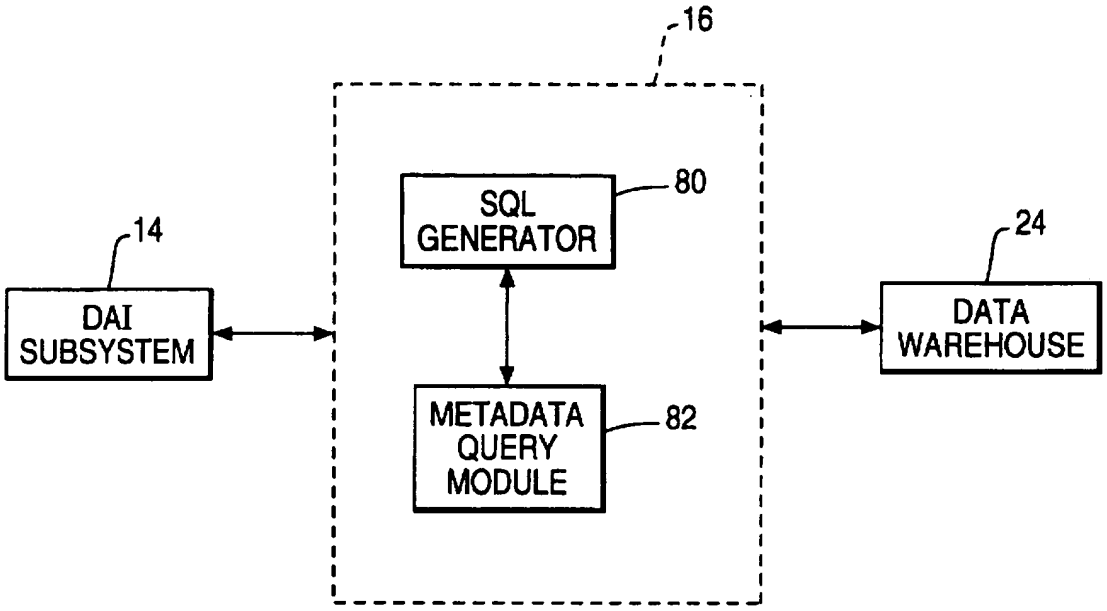
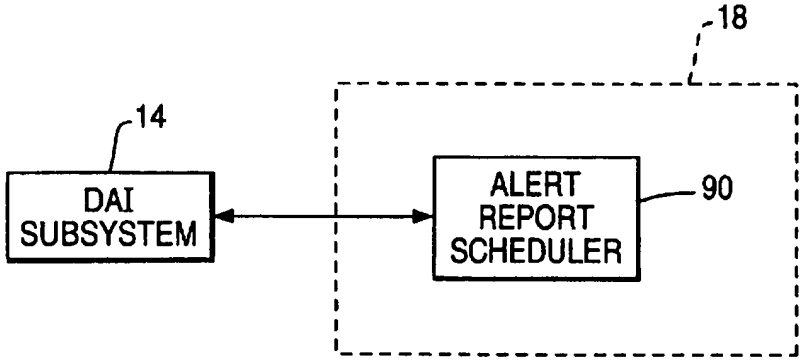

16
SQL GENERATOR
80
14
DAI SUBSYSTEM
24
DATA WAREHOUSE
METADATA QUERY MODULE
82

FIG. 5


18
14
DAI SUBSYSTEM
ALERT REPORT SCHEDULER
90

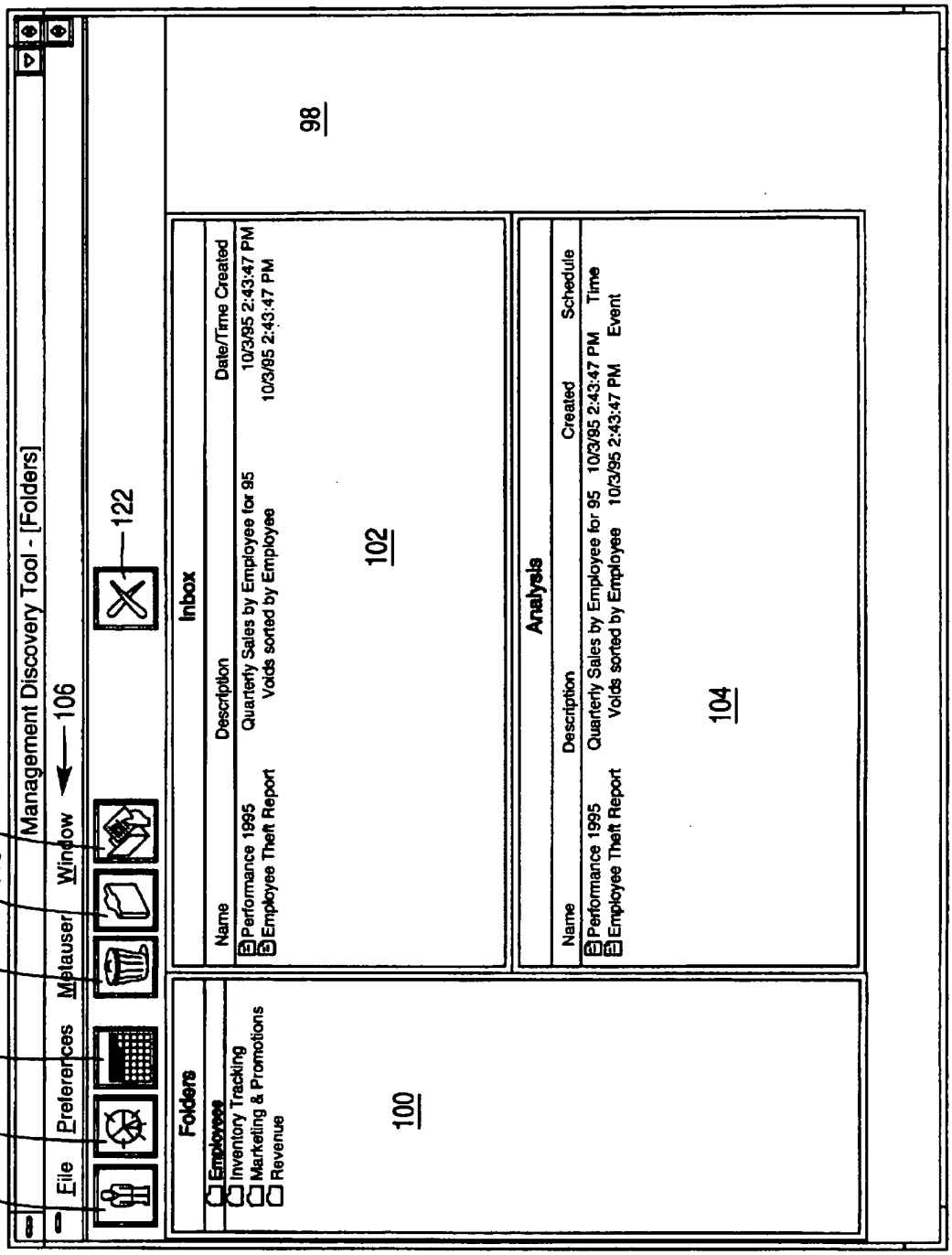
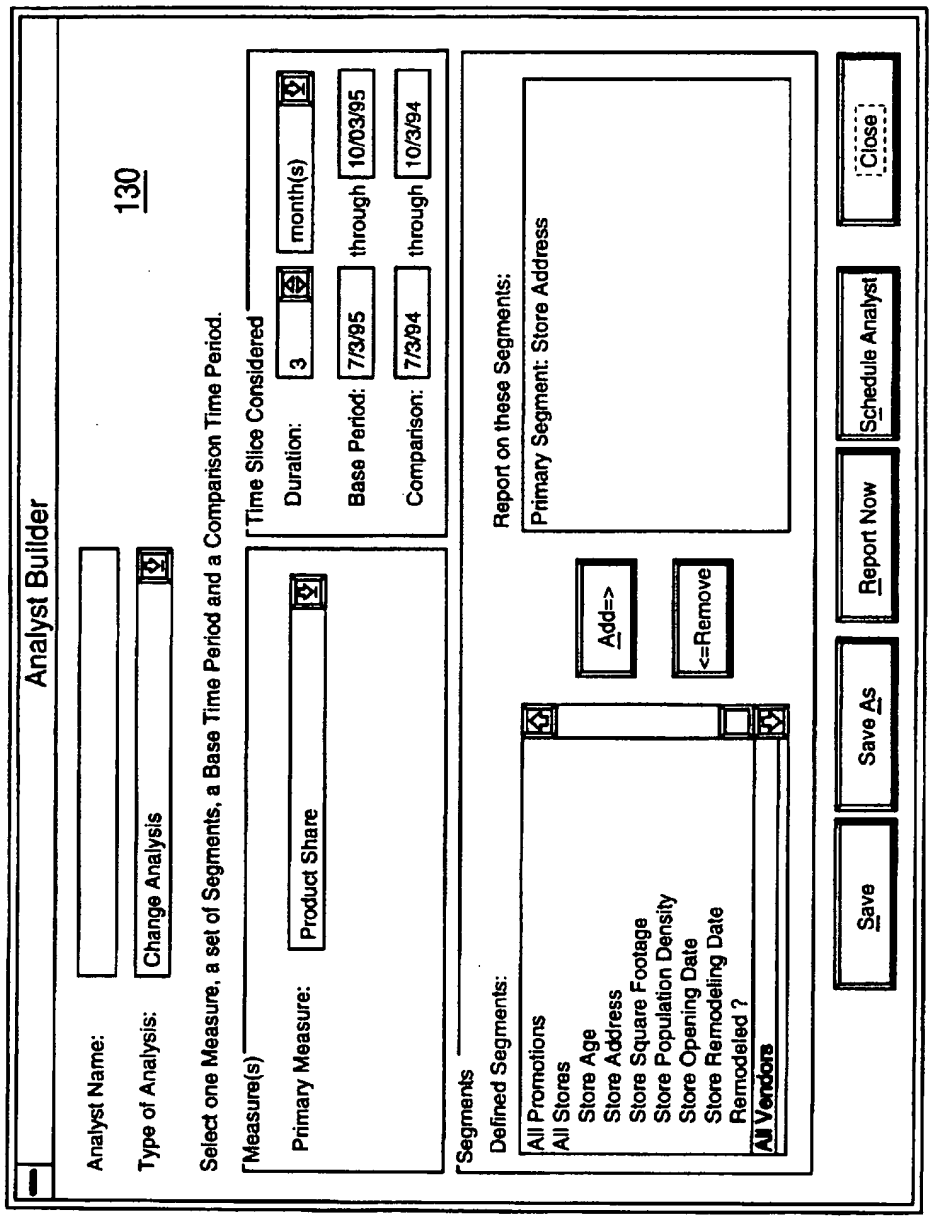

Management Discovery Tool - [Folders]
File
Preferences
Mplauser
Window
106
110
112
114
116
118
120
122
Folders
Employees
Inventory Tracking
Marketing & Promotions
Revenue
100
Inbox
Name
Description
Date/Time Created
Performance 1995
Quarterly Sales by Employee for 95
10/3/95 2:43:47 PM
Employee Theft Report
Voids sorted by Employee
10/3/95 2:43:47 PM
102
98
Analysis
Name
Description
Created
Schedule
Performance 1995
Quarterly Sales by Employee for 95
10/3/95 2:43:47 PM
Time
Employee Theft Report
Voids sorted by Employee
10/3/95 2:43:47 PM
Event
104

FIG. 6

FIG. 7


Analyst Builder
130
Analyst Name:
Type of Analysis:
Change Analysis
Select one Measure, a set of Segments, a Base Time Period and a Comparison Time Period.
Measure(s)
Primary Measure:
Product Share
Time Slice Considered
Duration:
3
month(s)
Base Period:
7/3/95
through
10/03/95
Comparison:
7/3/94
through
10/3/94
Segments
Defined Segments:
All Promotions
All Stores
Store Age
Store Address
Store Square Footage
Store Population Density
Store Opening Date
Store Remodeling Date
Remodeled ?
All Vendors
Add=>
<=Remove
Report on these Segments:
Primary Segment: Store Address
Save
Save As
Report Now
Schedule Analyst
Close

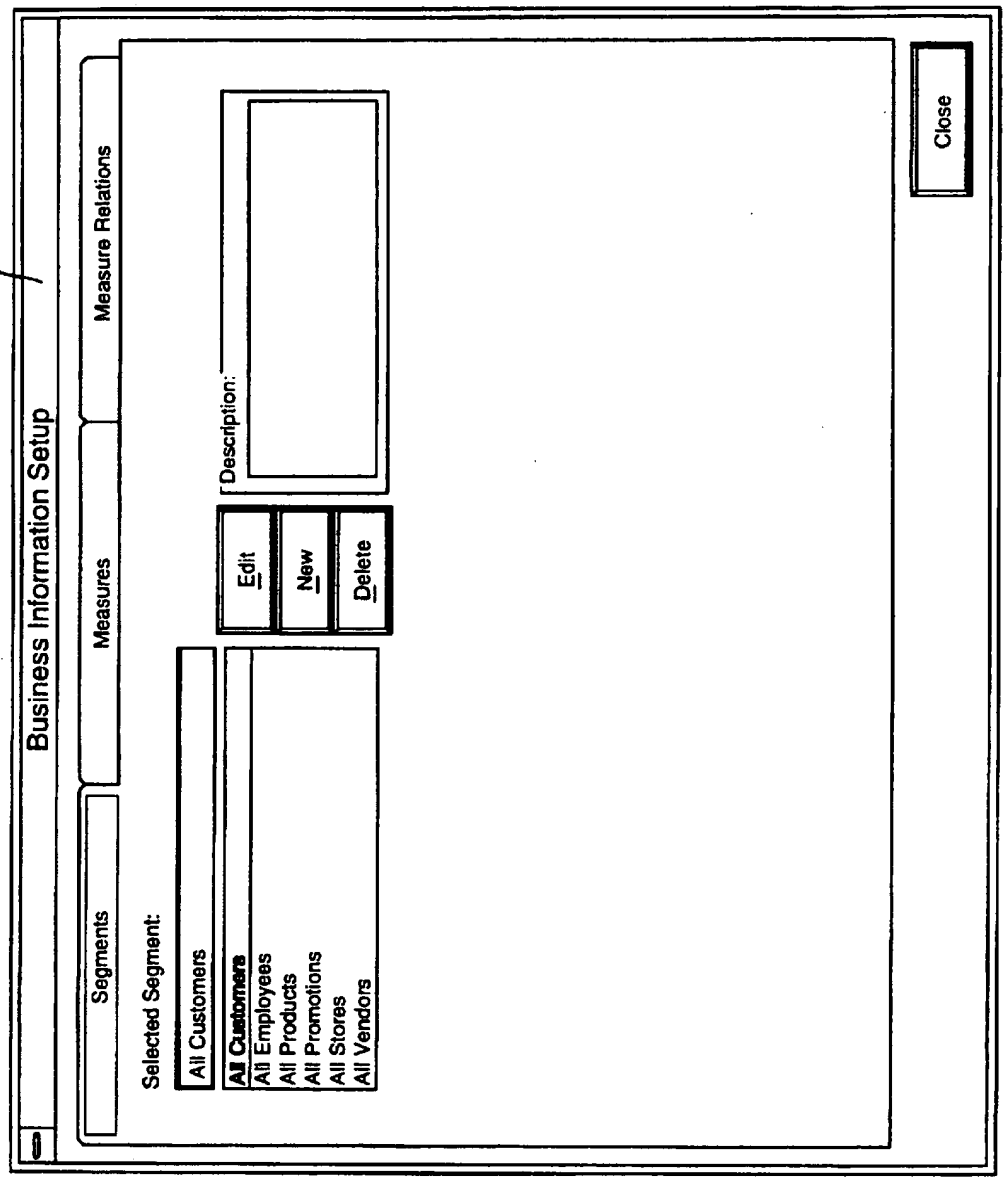

132
Business Information Setup
Segments
Measures
Measure Relations
Selected Segment:
All Customers
All Customers
All Employees
All Products
All Promotions
All Stores
All Vendors
Edit
New
Delete
Description:
Close

FIG. 8

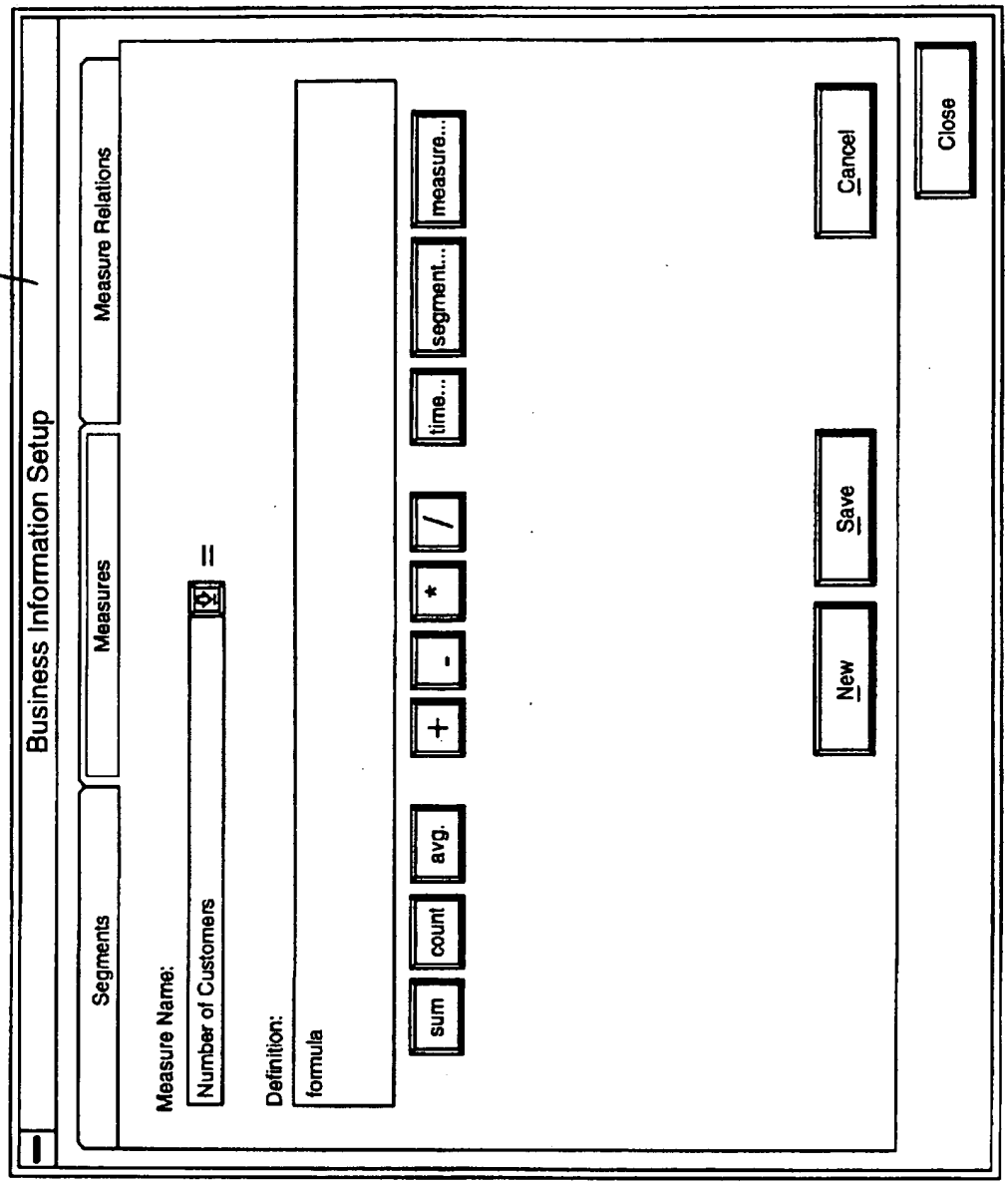

132
Business Information Setup
Segments
Measures
Measure Relations
Measure Name:
Number of Customers
=
Definition:
formula
sum
count
avg.
+
-
*
/
time...
segment...
measure...
New
Save
Cancel
Close

FIG. 9

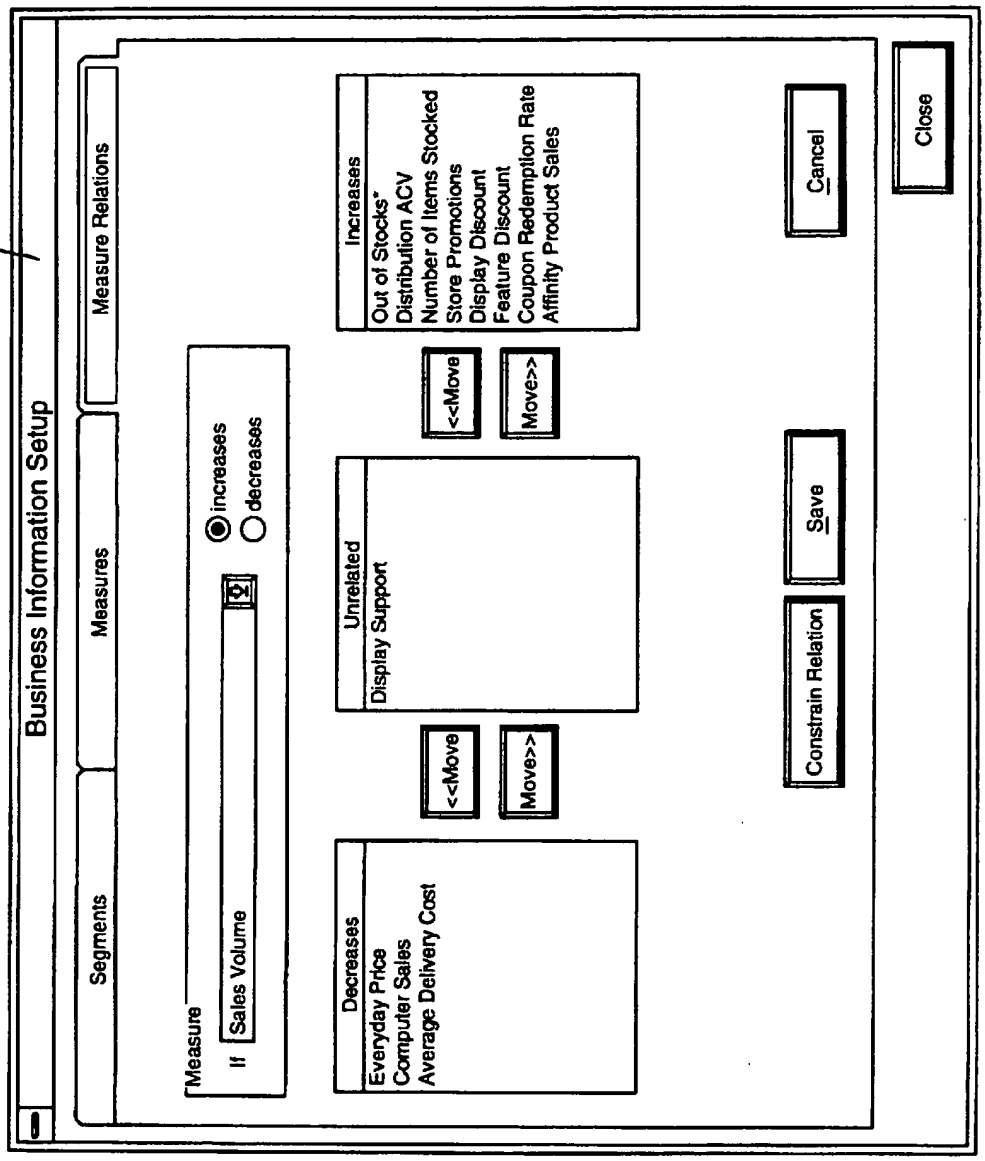

132
Business Information Setup
Segments
Measures
Measure Relations
Measure
If
Sales Volume
increases
decreases
Decreases
Everyday Price
Computer Sales
Average Delivery Cost
<<Move
Move>>
Unrelated
Display Support
<<Move
Move>>
Increases
Out of Stocks*
Distribution ACV
Number of Items Stocked
Store Promotions
Display Discount
Feature Discount
Coupon Redemption Rate
Affinity Product Sales
Constrain Relation
Save
Cancel
Close

FIG. 10

FIG. 11

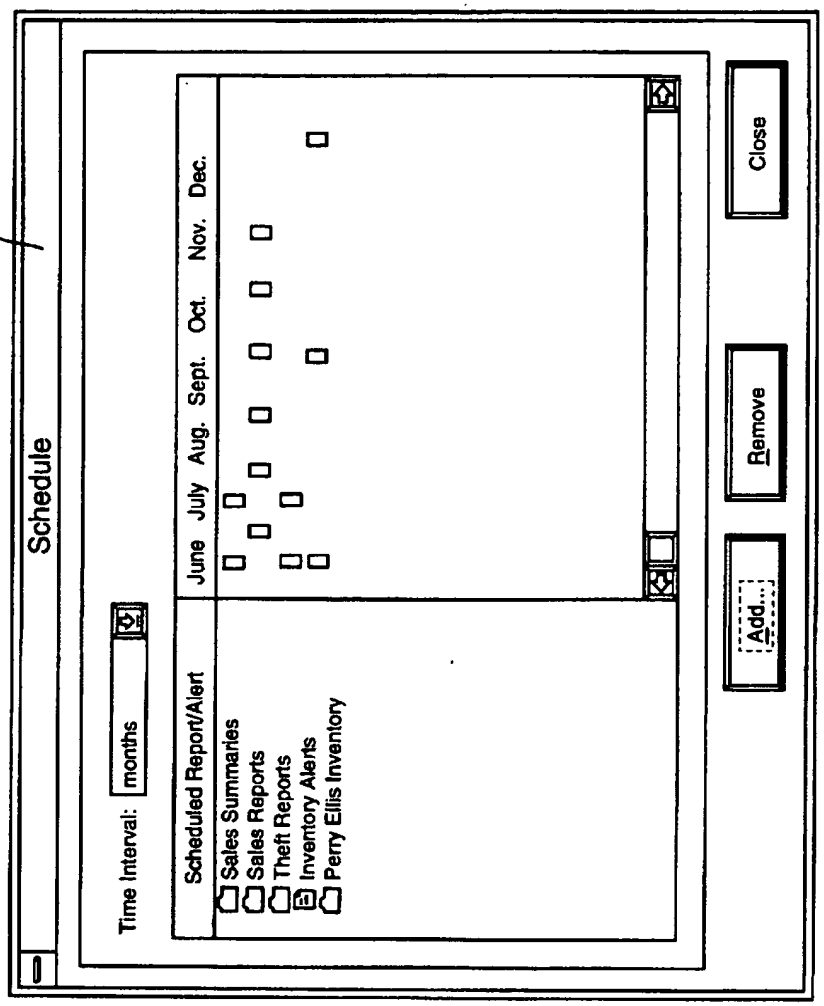

134
Schedule
Time Interval:
months
Scheduled Report/Alert
Sales Summaries
Sales Reports
Theft Reports
Inventory Alerts
Perry Ellis Inventory
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Add...
Remove
Close

FIG. 12

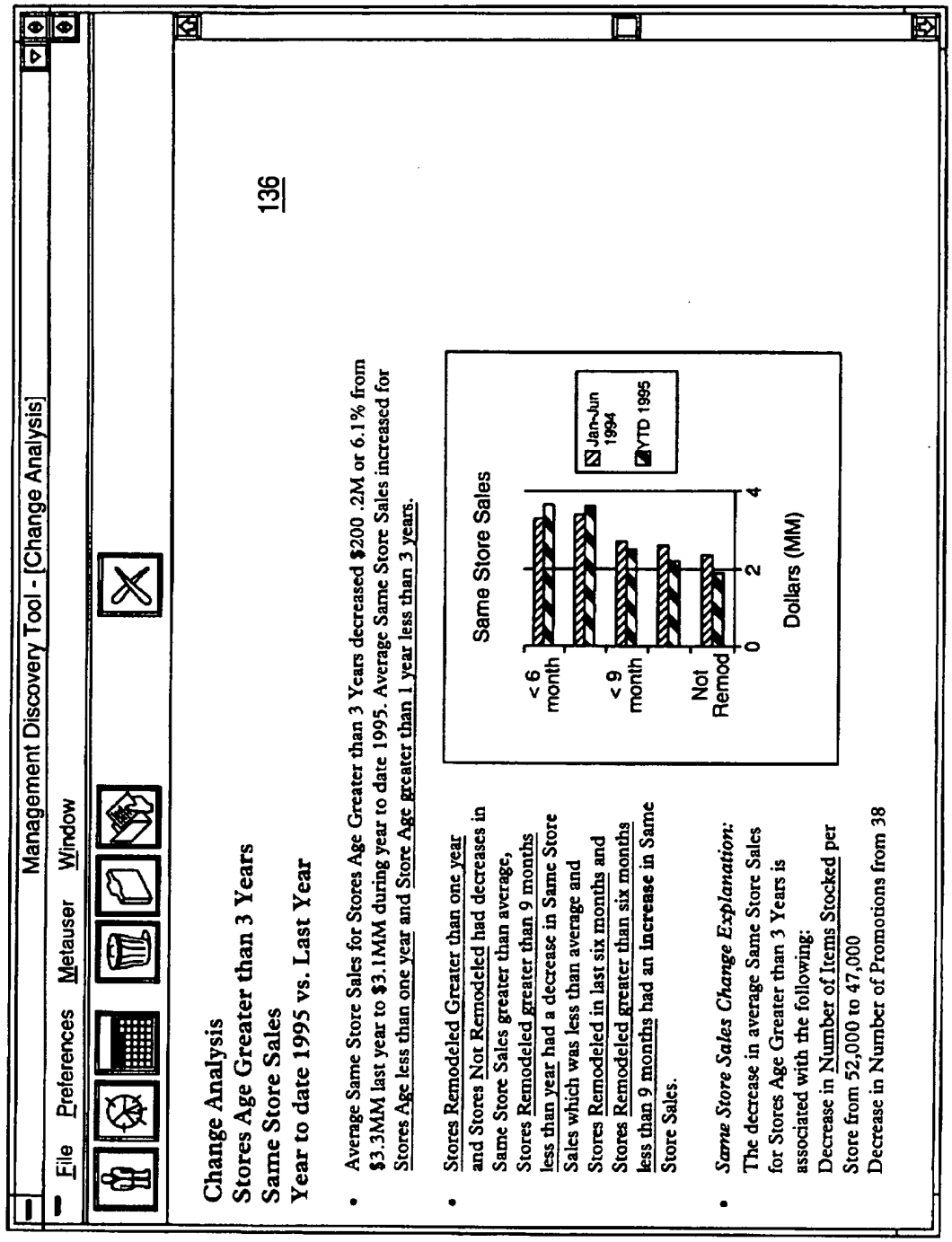
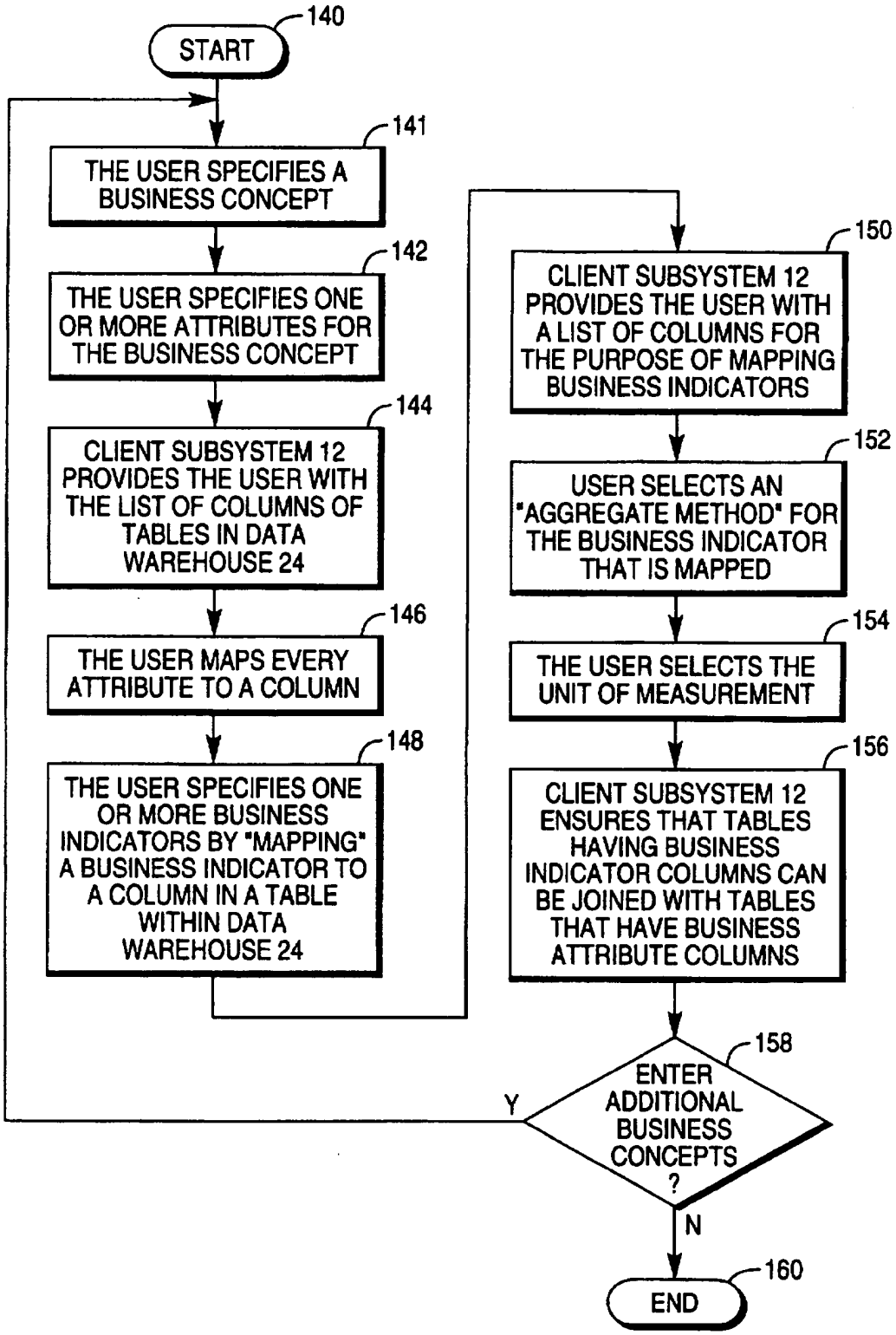

Management Discovery Tool - [Change Analysis]
File Preferences Metauser Window
Change Analysis
Stores Age Greater than 3 Years
Same Store Sales
Year to date 1995 vs. Last Year
136
• Average Same Store Sales for Stores Age Greater than 3 Years decreased $200 .2M or 6.1% from $3.3MM last year to $3.1MM during year to date 1995. Average Same Store Sales increased for Stores Age less than one year and Store Age greater than 1 year less than 3 years.
• Stores Remodeled Greater than one year and Stores Not Remodeled had decreases in Same Store Sales greater than average, Stores Remodeled greater than 9 months less than year had a decrease in Same Store Sales which was less than average and Stores Remodeled in last six months and Stores Remodeled greater than six months less than 9 months had an increase in Same Store Sales.
• Same Store Sales Change Explanation: The decrease in average Same Store Sales for Stores Age Greater than 3 Years is associated with the following:
Decrease in Number of Items Stocked per Store from 52,000 to 47,000
Decrease in Number of Promotions from 38
Same Store Sales
< 6 month
< 9 month
Not Remod
Jan-Jun 1994
YTD 1995
0
2
4
Dollars (MM)

FIG. 13


140
START
141
THE USER SPECIFIES A BUSINESS CONCEPT
142
THE USER SPECIFIES ONE OR MORE ATTRIBUTES FOR THE BUSINESS CONCEPT
144
CLIENT SUBSYSTEM 12 PROVIDES THE USER WITH THE LIST OF COLUMNS OF TABLES IN DATA WAREHOUSE 24
146
THE USER MAPS EVERY ATTRIBUTE TO A COLUMN
148
THE USER SPECIFIES ONE OR MORE BUSINESS INDICATORS BY "MAPPING" A BUSINESS INDICATOR TO A COLUMN IN A TABLE WITHIN DATA WAREHOUSE 24
150
CLIENT SUBSYSTEM 12 PROVIDES THE USER WITH A LIST OF COLUMNS FOR THE PURPOSE OF MAPPING BUSINESS INDICATORS
152
USER SELECTS AN "AGGREGATE METHOD" FOR THE BUSINESS INDICATOR THAT IS MAPPED
154
THE USER SELECTS THE UNIT OF MEASUREMENT
156
CLIENT SUBSYSTEM 12 ENSURES THAT TABLES HAVING BUSINESS INDICATOR COLUMNS CAN BE JOINED WITH TABLES THAT HAVE BUSINESS ATTRIBUTE COLUMNS
158
ENTER ADDITIONAL BUSINESS CONCEPTS ?
Y
N
160
END

SYSTEM AND METHOD FOR GENERATING REPORTS FROM A COMPUTER DATABASE

BACKGROUND OF THE INVENTION

The present invention relates to expert systems and reporting systems, and more specifically to a system and method for generating reports from a computer database.

Storing large amounts of transaction-level data for later analysis (data warehousing) is becoming recognized as an enabler for businesses that are seeking a competitive advantage. Tightening competitive environments and global economic trends are forcing businesses and entire industries to search for a means to gain an advantage. This advantage can be realized through the use of strategic data relating to their business—allowing better and more timely decisions, leading to a better understanding of their business and support for their customers, that ultimately leads to growth. To make use of data warehouses, the data must be retrieved, organized and then presented in an understandable format.

Discovery tools are used to retrieve, analyze and present data from data warehouses. These tools can range from very complex modeling tools to relatively simple end user query tools designed to do no more than mask the complexity of the SQL programming language from the user. Automated tools that search the data for trends or relationships are also considered discovery tools.

The marketplace is comprised of various tool vendors whose products provide solutions for a portion of the entire knowledge discovery process. Therefore, to effectively utilize their data, the user community is forced to pick multiple, disjoint tools. In addition, these tools are targeted toward the expert user who has an in-depth knowledge of the data and database formats or the various analytic methods that are implemented in the tool. Existing products also do not let the business user explicitly and iteratively represent business knowledge. Finally, the output of existing tools consists of tables of numbers that users have to analyze and interpret.

Data warehouses, and databases in general, typically have complex structure organized for efficiency of data retrieval, not ease-of-use by the end user. Users, especially business users, desire reports in their vocabulary, not the vocabulary of the database. While some tools in the marketplace allow a user to define new terms and map those terms to the database, the management of related sets of new terms is not supported. That is, the relationship of a new term to existing terms is not automatically detected for the user.

In addition to these difficulties, it is common for the contents of a report to cause a user to desire another, similar report. Saving and re-using sets of related reports (re-generating the reports over a new set of data) is also desired. The generation of related reports and the re-generation of reports over new data is a capability not adequately available in the marketplace.

Therefore, it would be desirable to provide a system and method for generating reports from a computer database which allow a user to retrieve and analyze data with one tool without requiring the user to have knowledge of underlying data structures or of the SQL programming language, which allow a user to define new terms and detect and manage relationships between terms, which allow a user to easily generate related reports, and which allow a user to re-run sets of related reports over new data.

SUMMARY OF THE INVENTION

In accordance with the teachings of the present invention, a system and method for generating reports from a computer database are provided.

A system and method for generating a report for a user which allows the user to make decisions, without requiring the user to understand or interpret data itself. A database management program executed by a server within a system for generating the report for the user includes a first subsystem for translating user requests for data, for generating dimensional queries for retrieving data from a database, and for processing user modifications to data types used in generating the report. A second subsystem coupled to the first subsystem reads data from the database, creates the data types, creates a mapping of the data types to the data, uses the mapping to translate user-initiated dimensional queries received from the first subsystem into Structured Query Language (SQL), and returns query results to the first subsystem. A third subsystem creates the report at a predetermined time.

It is accordingly an object of the present invention to provide a system and method for generating reports from a computer database which includes a single application or tool.

It is another object of the present invention to provide a system and method for generating reports from a computer database which allow a user to define and select variables and relationships between variables in creating a report.

It is another object of the present invention to provide a system and method for automatically detecting relationships between new terms entered by the user, and for managing these relationships in a hierarchy of related terms.

It is another object of the present invention to provide a system and method for generating related reports, and allow for the re-generation of related reports over new data.

It is another object of the invention to provide a system and method for iteratively entering business knowledge.

It is another object of the invention to provide a system that generates reports which combines natural language text, tables and graphs.

It is another object of the invention to provide a system that generates reports based on a user specified schedule or a user defined business exception.

It is another object of the invention to provide a system that is easy to use by business users who do not have knowledge of database formats, the SQL programming language and statistical or artificial intelligence based analytic methods.

It is another object of the invention to adhere to existing and emerging open systems standards.

It is another object of the invention to abstract data analysis into generic analyses. These analyses are Summarization, Change, Trend and Comparison.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional benefits and advantages of the present invention will become apparent to those skilled in the art to which this invention relates from the subsequent description of the preferred embodiments and the appended claims, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a block diagram of the system of the present invention;

FIG. 2 is a block diagram of a client subsystem within the system of FIG. 1;

FIG. 3 is a block diagram of a data abstraction intelligence subsystem within the system of FIG. 1;

FIG. 4 is a block diagram of a data and schema manipulation subsystem within the system of FIG. 1;

FIG. 5 is a block diagram of a scheduler subsystem within the system of FIG. 1;

FIGS. 6–12 are views of a tool for creating reports which employs a graphic user interface;

FIG. 13 is a flow diagram illustrating how metadata is created.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, system 10 includes four major subsystems: client subsystem 12, data abstraction intelligence (DAI) subsystem 14, data and schema manipulation (DSM) subsystem 16, and scheduler subsystem 18.

In connection with the description of system 10, the following definitions are provided:

An Alert Condition is a user-defined condition or set of conditions that when satisfied returns an Alert Message. For instance, an Alert Condition may be defined so that when the inventory of brand A shirts drops below 200 units for a given week, system 10 produces an Alert Message.

An Alert Message is a message that notifies the user that an Alert Condition has been satisfied. From an Alert Message the user can select any number of Smart Report Definitions to run. An example of an Alert Message would be "Alert: the inventory of brand A shirts is below 200."

An Alert Smart Report is a type of Smart Report that describes an Alert Message in detail. The Alert Smart Report has a description of what happened, when, and probable reasons why it occurred.

Business Concepts are high-level classifications within a certain business that are used to further describe indicators of the business' success (e.g., Customers, Products, Geography, Profitability). Each Business Concept has attributes that further define each Business Concept (e.g. Brand, Manufacturer, Size for the Business Concept Product).

Business Indicators are classifications across Business Concepts that are usually related to numerical values (e.g. Sales Volume, Inventory, Price). Business indicators have methods and formulae that pertain to their computation (e.g. Total Sales) and causal associations between Business Indicators (e.g. If Price increases Sales Volume should decrease). Within a Business Indicator, segments can be defined which describe a specific group of Business Indicators of interest (e.g. Senior Customer, Company A Products).

A Change Analysis Report is a compound document describing Business Indicators over two time periods. Within system 10, one can specify two periods of time and see the difference of a chosen Business Indicator for that period (e.g., How did this year's sales of textiles compare to last years sales?) Change Analysis Reports can report results for a day, week, month, quarter, year, or other defined period.

Compound Business Indicators are user-defined Business Indicators created by combining primitive Business Indicators with arithmetic and set operations.

A Data Warehouse is a very large collection of data that is housed in one or more databases. These databases usually reside on database server computers and can be either in one location or distributed geographically.

End Users are users for which system 10 is specifically designed. End users typically have knowledge of a business' operations and for this example have used the MICROSOFT WINDOWS operating system (i.e., the WINDOWS 3.1 operating system, the WINDOWS NT operating system, and the WINDOWS 95 operating system). End users typically do not have expertise in SQL code generation or the specific data structures of the databases they want to access.

Enterprise Information Factory (EIF) is a commercial software package that allows typical business users to access their data warehouse data. The data warehouse is essentially a passive environment that usually requires the use of SQL code and knowledge about the structure of the database to access data. The EIF differs from the data warehouse by providing a foundation for providing tools to allow users without SQL or database knowledge to get data out of their databases.

HyperText Markup Language (HTML) is an emerging standard format for software documents that allows for the inclusion of hyperlinks and graphics (pictures, graphs, tables) in text documents. A hyperlink is a "hot" area in the document (usually text in a different color than the surrounding text), that when clicked on, shows another document that is related or linked to the original HTML document.

System Administrators are those users of system 10 who have an intimate knowledge of the databases and data structures of an organization. Often the System Administrator has the title of "database manager".

Metadata is the collection of information about the end user's particular business. After installation this information is stored in the end user's database and is used to tailor reports to the end user's particular business needs. Metadata includes, but is not limited to, Business Concepts, Business Indicators and Segments.

Object Linking and Embedding (OLE) is a computer format that allows objects (e.g., graphs, tables) in computer documents to, when double clicked on, bring up the software application that created the object (graph, table, document).

Primitive Business Indicators are Business Indicators that are directly mappable to data in the data warehouse. They are set up during installation of the present invention and are not changeable by the user.

Segments are user-defined groups that are defined within a Business Concept having a meaningful attribute in common. For instance, the a segment "Senior Customers" might be those customers whose age is greater than 65 years.

Reports are compound documents that display data from a database in text and graphics (e.g., graphs, tables). Reports are the result of running a Smart Report Definition. Smart Reports are in the HTML format and are OLE 2.0 compliant.

Smart Report Definitions are System Templates that have been customized to include particular Business Concepts, Business Indicators, and/or segments. Smart Report Definitions can be immediately "run" to produce a "Smart Report", saved to be run later or saved and scheduled to be run later.

Structured Query Language (SQL) is a structured language for viewing the contents of a relational database.

Summarization Smart Report is a type of Smart Report that shows a roll-up or summarization of a specified Business Indicator across one or more specified Business Concepts or segments. By selecting a particular Business Indicator in this report a Smart Report showing the "winners" and "losers" for the specified period can be automatically produced.

System Templates are the internal templates for Smart Report Definitions that come with system 10. System 10 provides four System Templates; Summarization, Trend Analysis, Change Analysis, and Alert Monitoring. A System Template can be customized to create a Smart Report Definition by renaming it and selecting Business Concepts, Business Indicators and a time interval for that Smart Report Definition.

A Trend Analysis Smart Report is a type of Smart Report that, when defined, shows the trend for a specific Business Indicator or indicators over a specified period of time. This analysis can aid in forecasting the future by identifying patterns in past activities.

A Comparison Analysis Smart Report is a type of Smart Report helps a business user compare the value of two Business Indicators across the same time period or compare the value of the same Business Indicator across two sibling segments across the same time period.

Client subsystem **12** is a single application program which has a graphical user interface (GUI) **40** and which allows a user to select and specify parameters for Smart Reports, view Smart Reports, print Smart Reports, and save Smart Reports. Client subsystem **12** also displays to a user the results of performing Alerts. Finally, the user can specify Business Indicators and Segments, specify additional Alerts, or modify the schedule of Alerts client subsystem **12**.

DAI subsystem **14** provides intelligent middleware for translating graphical user requests, selecting system templates, manipulating data views, and generating dimensional queries for retrieving data from data warehouse **24**. It also contains rules for choosing default parameters, for choosing layout and display formats, and for generating text from data. DAI subsystem **14** is responsible for instantiating user selected Smart Reports and managing several kinds of metadata **25** used in this instantiation. This metadata **25** represents Business Concepts and Business Indicators that provide a customizable "dimensionalization" of the relational data in data warehouse **24**. DAI subsystem **14** also processes updates to this metadata **25** that originate in client subsystem **12** and handles several other kinds of user updates, primarily bypassing them to DSM subsystem **16**.

DSM subsystem **16** reads schema from data warehouse **24**, creates data views, and creates a mapping between the two. It also uses that mapping to translate the Dimensional Queries received from DAI subsystem **14** into SQL and package and return the results.

Scheduler subsystem **18** is responsible for launching Alerts and running any Smart Reports which the user specified to execute in batch mode at some specified time interval. When the requested time interval occurs, the Scheduler starts up, requests a list of Alerts and scheduled Smart Report Requests from DAI subsystem **14**. From those lists, scheduler subsystem **18** determines which should be run during the current time interval and sends those requests to DAI subsystem **14** as if they were sent by client subsystem **12**.

Thus, system **10** is implemented as a three-tier architecture. Client computer **30** executes client subsystem **12**. Client computer **30** preferably executes the WINDOWS 3.1 operating system, the WINDOWS NT operating system, or the WINDOWS 95 operating system, although other operating systems are also envisioned by the present invention. Client subsystem **12** (FIGS. **6–12**) is suitable for use with these operating systems. Display **22** and input device **21** allow a user to view GUI **40** and enter choices of metadata **25** used in creating Smart Reports. Input device **21** may be a keyboard, mouse, or other pointing device. Printer **23** allows a user to print a Smart Report. Storage medium **26** allows a user to store a Smart Report.

Server computer **32** executes DAI subsystem **14**, DSM subsystem **16**, and scheduler subsystem **18**. These three subsystems combine to satisfy user requests from client subsystem **12** using information from data warehouse **24**. Server computer **32** is preferably a multi-processor computer and executes the UNIX operating system or the WINDOWS NT operating system although other computer and operating system configurations are also envisioned by the present invention.

Client and server computers **30** and **32** are preferably coupled asynchronously for report requests; all other requests are satisfied synchronously. Communication between client and server computers **30** and **32** is preferably through transmission control protocol/internet protocol (TCP/IP), although other transmission protocols are also envisioned by the present invention.

Database computer **34** includes one or more storage media **36** containing data warehouse **24**. Database computer **34** is preferably a massively parallel processor computer and executes the UNIX operating system or the WINDOWS NT operating system, although other computer and operating system configurations are also envisioned by the present invention. Data warehouse **24** is suited to run on any computer which supports an Open Database Connect (ODBC) interface to data warehouse **24**. Communication between server computer **32** and database computer **34** is preferably via ODBC, although other database interfaces are also envisioned by the present invention.

Turning now to FIG. **2**, client subsystem **12** is an application program which gives a user control over system **10** and is suitable for execution on top of the WINDOWS 3.1 operating system, the WINDOWS NT operating system, or the WINDOWS 95 operating system. Client subsystem **12** includes log-in module **50**, folder management subsystem **54**, business information setup subsystem **55**, analyst definition subsystem **56**, Smart Report viewing subsystem **53**, master schedule subsystem **52**, and System Administrator interface **57**.

Log-in module **50** verifies that only one copy of the client subsystem **12** is running on computer **30**, checks the localization of computer **30**, connects to computer **32**, and interacts with the user to log him onto client subsystem **12**. During logon, log-in module **50** verifies a user's name and password and then retrieves any user preferences that may have been earlier defined. The only request from a user that is handled by log-in module **50** is a request to log onto client subsystem **12**.

Log-in module **50** issues the following requests:

single program running	to Operating System (DOS, NT, WINDOWS 95)
retrieve localization	to Operating System (DOS, NT, WINDOWS 95)
connect to server	to Client/Server module
disconnect from server	to Client/Server module
authenticate user	to Metadata API
run main menu	to Main Menu
run admin menu	to System Administrator Interface

If the user is the System Administrator, log-in module **50** displays System Administrator interface **57**. If the user is a regular user, a Main menu and toolbar interface **51** are displayed.

System Administrator interface **57** is used by a System Administrator to perform system administration tasks, such as making user-defined segments available globally and creating and editing Business Concepts. Interface **62** is preferably only available to System Administrators during system installation.

Folder management subsystem **54** handles all functions related to manipulating, storing, and retrieving Folder

hierarchies, and the Smart Reports and Agents that are stored in those Folders. It also handles querying from DAI subsystem **14** for newly-completed Smart Reports, both when client subsystem **12** starts up, and then periodically thereafter.

Folder management subsystem **54** also handles User requests for operations on:

Folders (new, delete, rename)

Agents (edit, delete, run now, print)

Smart Reports (view, delete, print [in cooperation with the Smart Report View Window])

Each folder is represented by one folder object. A folder stores a list of child folders, a list of Smart Reports, and a list of Agents. Folder objects are created and deleted by folder management subsystem **54** in response to user requests.

Business information setup subsystem **55** provides a user with the ability to create new measures, update measures, or delete existing measures. This information is sent to a Metadata API 60 and thereafter to DAI subsystem **14** for updating the user's Metadata 25.

Business information setup subsystem **55** provides a user with the ability to create new Sediments, update segments, or delete existing Segments. This information is sent to a Metadata API 60 and thereafter to DAI subsystem **14** for updating the user's Metadata 25.

Finally, business information setup subsystem **55** provides a user with an interface to modify measure relations and to constrain measure relations. The user selects the current measure and whether to evaluate that measure's relationships when it increases or decrease. Then the user can then select from a list of other measures and define their relationship to the current measure. These relationships are in the form of "decreases", "increases", or "is unrelated to the current measure". Also, every relationship between two measures can be constrained. The relationship between measures and the constraints placed upon them are saved on computer **32** for use in generating Smart Reports.

Analyst definition subsystem **56** handles all functions related to user selection of parameters needed to generate specific reports. It also allows the user to define and schedule Alerts for scheduled reports.

The user may invoke an existing Analyst, delete one from within the folder management subsystem **54**, or create a new Analyst. There are five types of Analysts are:

Summarization

Segment Comparison

Measure Comparison

Change Analysis

Trend Analysis

The Summarization Analyst requires the following user selection requirements:

Analyst name

Primary measure, other optional measures

Primary segment, other segments

Time segment

The Segment Comparison Analyst requires the following user selection requirements:

Analyst name

Primary measure

Primary segment, a comparison segment

Time segment.

The Measure Comparison Analyst requires the following user selection requirements:

Analyst name

Primary measure, Comparison measure

Primary segment, other optional segments

base time segment, comparison time segment.

The Change Analysis Analyst requires the following user selection requirements:

Analyst name

Primary measure

Primary segment, Other optional segments

base time segment, comparison time segment.

The Trend Analysis Analyst requires the following user selection requirements:

Analyst name

Primary measure

Primary segment, other optional segments.

Time segment, Time interval.

The user is responsible for selecting one or more measures, a base period, and a comparison period. The user then can save, submit, and schedule the analyst definition. The user is restricted to choosing one Segment from within each Business Concept with the exception of Target Segment, in which case he may select only one segment and more than one child partition of the selected segment. The user may choose to schedule an Smart Report to be generated periodically. All Analyst Definition objects are scheduled. The user may modify an attached schedule.

Used for exception monitoring, all analyst Definitions will have a trigger object attached to them. If a user decides not to have any triggers, a null trigger object will be attached to Analyst Definition Object.

The Analyst definition subsystem **56** makes the following requests to the folder management subsystem **54**:

Save	Check if the user has selected the appropriate parameters for the selected analyst. Send a request to the folder management subsystem 54 to save an existing Analyst Definition
Save As	Check if the user has selected the appropriate parameters for the selected analyst. Send a request to the folder management subsystem 54 to save an existing Analyst Definition
Submit	Check if the user has selected the appropriate parameters for the selected analyst. Send a request to the folder management subsystem 54 to submit a report generation

The Analyst definition subsystem also makes the following requests to Metadata API 60:

Get all Measures	The request will be made to Metadata API 60 each time there is a need for it at the initialization point of a dialog
Get all Business Concepts	The request will be made to Metadata API 60 subsystem each time there is a need for it at the initialization point of a dialog
Get a Business Concept's Partitions	The request will be made depending on a user's selection of a business concept
Get Partitions	The request will be made depending on a user selection of a defined Segment.

-continued

Get Segments	The request will be made depending on a user selection of a partition.

Smart Report viewing subsystem **53** includes a "what-you-see-is-what-you-get" (WYSIWYG) browser which displays a selected Smart Report on screen, when Smart Report viewing subsystem **53** gets a notification from folder management subsystem **54** to view a Smart Report. If the user decides to drill down from the current Smart Report, Smart Report viewing subsystem **53** notifies the folder management subsystem **54** to send a new report request.

When the user double-clicks on an Smart Report or chooses "menu item -View" from the File menu in the Inbox Manager, the folder management subsystem **54** notifies the Smart Report viewing subsystem to view the Smart Report. When the user clicks on a hypertext to drill down from the current Smart Report, the Smart Report viewing subsystem **53** passes the drill down information to the folder management subsystem **54** to send a new report request to DAI subsystem **14**.

Smart Report viewing subsystem **53** includes a parser which parses the Smart Report, which is in an HTML file. In an HTML file, HTML tags indicate document elements, structure, formatting, and hypertext linking to other documents or to included media. The parser then outputs all the information for display.

The Smart Report viewing subsystem **53** allows a user to display and format text, tables, and graphs displayed by display **22** based on the information gathered by the parser. A header, a footer, and annotations can be added to a Smart Report. The user can save the viewed Smart Report. The user can also save an Smart Report as a HTML file in either UNICODE or ASCII code format. A saved HTML Smart Report can be attached to an e-mail to mail out. Any HTML version 3.0 browser can read the HTML Smart Report.

The master schedule subsystem **52** allows the user to view the scheduling of all Smart Reports. It also allows the user to add or delete a schedule from an Analyst Definition.

Master schedule subsystem **52** calls the folder management subsystem **54** to get a list of all the folders to be displayed. Then it displays in graphic form the scheduling of each Smart Report. The user can add, delete or modify a schedule and send a changed Report Definition Object back to folder management subsystem **54**. concepts using metadata API 60.

Metadata API 60 handles most of the communications between client subsystem **12** and DAI subsystem **14**. These communications involve four basic types of data: metadata **25**, Smart Reports, user profiles, and data warehouse schema. For metadata communication, Metadata API 60 provides the ability to add, delete and update metadata **25**. For Smart Reports, Metadata API 60 provides the ability to request a report, get the status of a report, retrieve a report and cancel a report request. For user profiles, Metadata API 60 provides the ability to add a user, authenticate a user and delete a user. The communication for data warehouse schema is to retrieve it.

Metadata API 60 allows a user to define new ways of looking at his business. A user cannot modify the segments that were created during installation. However, he can create new Business Indicators and new Segments. In a typical organization of users and system administrators, only system administrators can create or change business

The MetaData API will handle the following requests from other client subsystems:

update metadata	from Business Information Setup subsystem 55
get report status	from Folder management subsystem 54
generate report	from Folder management subsystem 54
retrieve report	from Folder management subsystem 54
retrieve schema	from System Administrator Interface 57
update schedule	from Analyst Definition subsystem 56
cancel a report	from Analyst Definition subsystem 56
authenticate user	from Log-in module 50
add a user	from System Administrator Interface 57
delete a user	from System Administrator Interface 57
update user password	from System Administrator Interface 57

Metadata API 60 sends the following requests directly to DAI subsystem **14**:

disconnect from computer **32**

send data to DAI subsystem **14**

receive data from DAI subsystem **14**

Turning now to FIG. **3**, DAI subsystem **14** includes return area manager **70**, Smart Report generator **72**, metadata request module **74**, metadata repository **76**, and metadata load and update module **78**.

Metadata repository **76** contains a representation of metadata **25** within data warehouse **24**. This metadata **25** is the core of system **10**; it provides a customizable business view over the relational data in warehouse **24** and is the primary vocabulary for the specification of Smart Reports. Metadata repository **76** gets populated at startup time by DSM subsystem **16** from the persistent metadata representation in data warehouse **24**.

There are four fundamental kinds of metadata **25** in metadata repository **76**, listed and described below:

Business Concepts: business concepts represent the business dimensions along which the data can be viewed. Each dimension imposes a hierarchy over the underlying data, and dimensions can be combined to drive "drill-down" or "drill-up" operations. For example, a simple retail application might have two Business Concepts: Market and Product. The Market hierarchy is composed of Sales Regions, each of which consists of several States, each of which consists of a set of Stores. The Product Hierarchy is composed of a set of Departments (Home Electronics, Men's Clothing, Hardware), each Department is composed of product Categories (Shirts, Shoes, Slacks), and each Category is composed of individual manufacturer's product lines. Time is a Business Concept that is important in all applications, and will be represented in system **10**. Users can add new Business Concepts (see below). These, as all of the metadata **25** in metadata repository **76**, must be mapped into relational form (that is, into SQL) in order to actually query data warehouse **24**. Mapping is done by DSM subsystem **16** during the process of processing Dimensional Queries (see below).

Business Indicators: Business Indicators are the important measures of data of interest. For example, product Volume, Price, or Current Stock are all Business Indicators. The use of time in a query further refines the idea of a Business Indicator; for example, "Change in Volume" applies between two time periods.

Alerts: Alerts are essentially tests over the data, stated in terms of Business Concepts and Business Indicators, and

are typically used to generate Exception Monitoring Smart Reports. For example, a user might specify that if the available stock of a product falls by some percentage, to generate the appropriate Smart Report. The user also specifies how often to check the Alert condition. A list of Alerts is maintained by DAI subsystem **14** and executed by scheduler subsystem **18**. This metadata **25** is also available to DAI subsystem **14** and is used to generate Smart Report information.

Causal Indicators: Causal Indicators are simple expressions of business causality; for example, "Increased Sales mean Increased Profit". This kind of metadata **25** is used to generate supporting information for a Smart Report or, alternatively, alert the user to trends that run counter to the set of Causal Indicators.

Metadata 25 is initially created during installation of the present invention at the customer's site. The process of creating the metadata **25** is illustrated in more detail in FIG. **7**. What is included within metadata **25** depends on the industry (some metadata **25** will be industry-specific and usable by all companies in that industry), the specific customer of the present invention, and the structure of the customer's data warehouse **24**. During installation, some industry-specific metadata **25** is used, some company specific metadata **25** may be created, and the mapping information needed to map metadata **25** to data warehouse **24** is created. All metadata **25**, including the mapping information, is stored in a set of relational tables. These relational tables are kept in data warehouse **24** and used by the present invention to create reports for the user.

Metadata request module **74** handles all requests for metadata **25**, either from client subsystem **12** or DAI subsystem **14**. Client subsystem **12** requests metadata **25** from DAI subsystem **14** to be presented to the end users. Smart Report generator **72** requests metadata **25** in order to create Dimensional Queries as part of instantiating a Smart Report for a user. A request for metadata **25** might be, for example, a request for all sub-concepts of a particular Business Concept.

Metadata request module **74** also handles metadata updates from client subsystem **12**. A user adds new Segments by specifying a new dimension from which to group the data. This dimension must be supported by an existing data attribute in the warehouse data. For example, a Product may include a List-Price and a Discount-Price. The user can specify a new dimension called "Discount-Factor", specified using the percent difference between the Discount-Price and the List-Price, and use that to create three new Segments: Heavily-Discounted Products, Slightly-Discounted Products, and Non-Discounted Products. These new Segments can now be used in subsequent Smart Report requests, and, if indicated by the user, made persistent by writing them back into data warehouse **24** by metadata load and update module **78**.

Request Structures are passed from one subsystem to another when one subsystem requires processing and results from another. Request Structures vary according to the type of request being sent. Most requests, however, have some common attributes, such as an identification field, an owner, a name and a description of the request.

Request Structures primarily include Alert Evaluation Requests and Alert Update Requests. Alert Evaluation Requests are sent from client subsystem **12** to DAI subsystem **14**. Alert Evaluation Requests are requests to evaluate an Alert condition to determine if it is true. The request has the following format:

AE_ID: ID which uniquely identifies this Alert Evaluation
OWNER: The user who created this Alert Evaluation
AE_NAME: The name of this Alert Evaluation
AE_DESC: The description of this Alert Evaluation
ALERT_ID: The Alert which contains the condition for evaluation

Alert Update Requests are sent from client subsystem **12** to DAI subsystem **14**. This type of request is to schedule a new Alert. The request has the following format:

ALERT_ID: ID which uniquely identifies this Alert
OWNER: The user who created this Alert
ALERT_NAME: The name of this Alert
ALERT_DESC: The description of this Alert
SEG_ID: A segment specified for this Alert
BI_ID: A Business Indicator specified for this Alert
OP: The operator for this Alert
THRESHOLD: The threshold value which triggers the Alert
ENABLED: Specifies if the Alert is currently enabled or disabled
START: The starting date for the Alert
INTERVAL: How often should the Alert be checked

Business Concept Update Requests are sent from client subsystem **12** to DAI subsystem **14** and are preferably issued only by the System Administrator. Business Concept Update Requests are requests for adding a new Business Concept to the metadata **25**. The requests have the following format:

BC_ID: ID which uniquely identifies this Business Concept
BC_NAME: The name of this Business Concept
BC_DESC: The description of this Business Concept
MAPPING: Mapping of this Business Concept to data warehouse tables

Business Indicator Update Requests are sent from client subsystem **12** to DAI subsystem **14**. Business Indicator Update Requests are requests for adding a new Business Indicator to the metadata **25**.

Business Indicator Update Requests primarily include primitive and compound requests. Primitive requests have the following format:

BI_ID: ID which uniquely identifies this Business Indicator
OWNER: The user who created this Business Indicator
BI_NAME: The name of this Business Indicator
BI_DESC: The description of this Business Indicator
MAPPING: Mapping of this Business Indicator to data warehouse tables
ROLLUP_OP: Operator for performing the roll-up operation

Compound requests have the following format:

BI_ID: ID which uniquely identifies this Business Indicator
BI_NAME: The name of this Business Indicator
BI_DESC: The description of this Business Indicator
EXP: The expression which describes this Business Indicator function

Causal Indicator Update Requests are sent from client subsystem **12** to DAI subsystem **14**. Causal Indicator Update Requests add a new Causal Indicator to the metadata **25**. The request has the following format:

CI_ID: ID which uniquely identifies this Casual Indicator
OWNER: The user who created this Causal Indicator
CI_NAME: The name of this Causal Indicator
CI_DESC: The description of this Causal Indicator
BI_ID1: Business Indicator which is the independent variable of this causal relationship
OP: The operator for this causal relationship
BI_ID2: Business Indicator which is the dependent variable of this causal relationship
RANGE: When OP is +/−, the range where it is + and the range where it is −

Schema Requests are sent from client subsystem **12** to DAI subsystem **14** and may only be issued by the System Administrator. Schema Requests are requests to retrieve the data base schema from data warehouse **24**. This type of request is just a simple unformated message to DAI subsystem **14**.

Segment Update Requests are sent from client subsystem **12** to DAI subsystem **14**. Segment Update Requests are requests for adding a new Segment to the metadata **25**. Segment Update Requests have the following format:

SEG_ID: ID which uniquely identifies this Segment
OWNER: The user who created this Segment
SEG_NAME: The name of this Segment
SEG_DESC: The description of this Segment
SEG_LEVEL: Level in the Segment Hierarchy of this Segment
BC_ID: The Business Concept for this Segment
ATTR_ID: The Attribute(s) for this Segment
OP: The operator(s) for this Segment
VALUE: The value (s) for this Segment

Smart Report Requests are sent from the Client subsystem to the DAI subsystem. This type of request is to create a new Smart Report based on user specified selections. The request has the following format:

SR_ID: ID which uniquely identifies this Smart Report
OWNER: The user who created this Smart Report
SR_NAME: The name of this Smart Report
SR_DESC: The description of this Smart Report
SR_TYPE: One of the four types of Smart Reports
BC_ID: The Business Concept for this Smart Report
SEG_ID: The Segment(s) for this Smart Report
TIME: The time interval(s) for this Smart Report

Dimensional Queries are sent from DAI subsystem **14** to DSM subsystem **16**. Dimensional Queries formulate requests for data from data warehouse **24**. DSM subsystem **16** converts Dimensional Queries into SQL statements. A Dimensional Query conforms to the following format:

```
dq          :  concept_list ';' indicator ';' time
            ;
concept     :  CONCEPT_NAME ':' SEGMENT_NAME
            ;
concept_list:  concept
            |  concept_list ',' concept
            ;
indicator   :  INDICATOR_NAME
            ;
time        :  INTERVAL_NAME
            ;
```

Client subsystem **12** produces the following outputs to DAI subsystem **14**:

Alert Evaluation Requests
Alert Update Requests
Business Concept Update Requests
Business Indicator Update Requests
Causal Indicator Update Requests
Schema Requests
Segment Update Requests
Smart Report Requests
Cancel Requests

DAI subsystem **14** provides the following outputs to client subsystem **12**:

Alert Evaluation Structures
Alert Structures
Business Concept Structures
Business Indicator Structures
Causal Indicator Structures
Schema Structures
Segment Structures
Smart Reports
Retrieve Alert Evaluations Requests
Retrieve Smart Reports Requests
Error/Status Codes

DAI subsystem **14** provides the following outputs to scheduler subsystem **18**:

Alert Evaluation Lists
Scheduled Smart Report Lists
Alert Evaluation Structures
Smart Reports
Retrieve Alert Evaluations Requests
Retrieve Smart Reports Requests

DAI subsystem **14** provides the following outputs to DSM subsystem **16**:

Dimensional Queries
Metadata Retrieval Requests

DSM subsystem **16** provides the following outputs to DAI subsystem **14**:

Updated Metadata
Data from the Data Warehouse

DSM subsystem **16** provides the following outputs to data warehouse **24**:

SQL Statements

DSM subsystem **16** receives the following inputs from data warehouse **24**:

Metadata
Database Schema
Warehouse Data

Scheduler **18** provides the following outputs to DAI subsystem **14**:

Alert Evaluation Requests
Smart Report Requests

Metadata load and update module **78** populates metadata repository **76** from the persistent metadata stored in data warehouse **24** upon system startup. In addition, when a user specifies new Business Concepts and indicates that he wants them saved, metadata load and update module **78** writes them back into data warehouse **24** for future use.

Smart Report generator **72** fulfills the primary purpose of DAI subsystem **14**. Report generation begins when a user chooses a Smart Report and an appropriate set of parameters in client subsystem **12**. This Smart Report Request is used to first fetch a System Template. A System Template consists of a set of Abstract Queries. An Abstract Query contains placeholders for Business Concepts and Business Indicators that are filled in with the user selections in the process of instantiation, as well as conditions that are evaluated to generate different output and actual layout information. The output of the Report Generation process is a fully instantiated Smart Report returned to client subsystem **12** in the form of HyperText Markup Language (HTML), a widely-used standard for building WYSIWYG compound documents.

Smart Report generator **72** has several kinds of knowledge:

Knowledge of how to map Abstract Queries into Dimensional Queries
Knowledge of how to use metadata **25** to generate default choices (choices not made by the user in the Smart Report Request)
Knowledge of how to use both metadata **25** and data returned from the warehouse to guide the selection of both text components
Knowledge of how to use both metadata **25** and data returned from the warehouse to guide the selection of different types of graphical presentations.

For example, the Summary Smart Report may take as arguments a Business Concept, a Business Indicator, and a time period. It may also contain an Abstract Query that says "Retrieve the Target-Business-Indicator for the Target-Concept at the Target-Time-Period". The Report Generation Module uses the user selected parameters, for example, the Business Concept "Product", the Business Concept Segment "Men's Shirts", the Business Indicator "Volume", and the time period "December 1994" to create a Dimensional Query. This Dimensional Query is sent to the Data and Schema Manipulation subsystem, which translates this query into SQL and actually executes it. It returns the computed data to DAI subsystem **14**, where other Abstract Queries might embed the actual number in a bullet.

Other Abstract Queries have conditionals associated with them. To build off the previous example, another part of the summary System Template might specify the creation of a graph, showing how the target-business-indicator (volume) is apportioned among the segments of the target-business-concept (shirts). In this case, report generator **72** makes a metadata request to return the set of segments, in this example, the dimension that specifies the shirt manufacturer. All volume information is requested for each manufacturer of shirts. Now, additional information guides report generator **72** in the selection of a choice of graph. For example, if the number of segments (manufacturers in this case) is small, like 7 or less, then a pie graph is appropriate, otherwise, a bar graph is preferred. If the number of segments is very large, then aggregate the bottom 20 percent (in terms of the Business Indicator, in this case, Volume) and use that aggregate with the label "Other" in the graph.

Return area manager **70** keeps track of Smart Reports and Alert Evaluations with positive results by user that are waiting for delivery to client subsystem **12**. When a user logs into system **10**, client subsystem **12** issues a request to DAI subsystem **14** to return all data for that user in the return area. Return area manager **70** retrieves the information from the return area on server computer **32** and sends it back to client computer **30** through DAI subsystem **14**.

Turning now to FIG. **4**, DSM subsystem **16** includes SQL generator **80** and metadata query module **82**.

SQL generator **80** translates dimensional queries received from DAI subsystem **14** into SQL statements used to retrieve data from data warehouse **24**. A mapping from business concepts to database entities is stored in the metadata **25** and is used in the formatting of the SQL statements. SQL generator **80** provides to DAI subsystem **14** for use in creating Smart Reports.

Metadata query generator **82** processes requests for metadata **25** submitted by DAI subsystem **14**. At system startup, DAI subsystem **14** requests all metadata **25** in order to initialize the knowledge base. Metadata query generator **82** is also invoked whenever the user modifies his Segments, causing DAI subsystem **14** to issue an update metadata request.

Turning now to FIG. **5**, scheduler subsystem **18** includes alert and report scheduler **90** schedules processes to run at user specified times of day and at user specified intervals which are selected at system installation time by the System Administrator. Alert and report scheduler **90** issues Smart Report requests to DAI subsystem **14** for all batch-scheduled Smart Reports. Alert and report scheduler **90** also issues Alert Evaluation Requests to DAI subsystem **14** when it runs. If the Alert Evaluation condition is true, the user will be notified the next time he logs into system **10**.

Turning now to FIGS. **6–12**, client subsystem **12** and its operation are illustrated in more detail.

Client subsystem **12** includes a primary overlay **98** which appears when client subsystem **12** is executed. Overlay **98** includes three display areas **100–104** within a common Folders window, pull-down menus **106**, and buttons **110–120**. The Folders window may be maximized (as it is shown in FIG. **6**) to eliminate its borders, resized, or minimized as an icon within client subsystem **12**. The Folders window cannot be closed.

Display area **100** contains a list of folders, which represent the metaphor used by client subsystem **12** in organizing Smart Reports and the analysis that creates them. A folder is opened by highlighting it and selecting it with input device **21**. The first folder in the list is opened by default when client subsystem **12** is executed.

Display area **102** contains a list of Smart Reports within a selected folder. A Smart Report may be viewed by highlighting it and selecting it with input device **21**. An Analysis window **136** appears containing the Smart Report. The title bar of the window indicates the type of preselected analysis that has been performed. For example, in FIG. **12**, "change" analysis was preselected by a user to be the type of analysis to run. The Analysis window **136** may be maximized (as it is shown in FIG. **12**) to eliminate its borders, resized, or minimized as an icon within client subsystem **12**. The Analysis window **136** may be closed by selecting button **124** (FIG. **12**) or by a manner well known to users of WINDOWS 3.1 operating system and other windows operating environments.

Display area **104** contains a list of Analysts within a selected folder. An Analyst is a personification of preselected operations performed on preselected data for the purpose of generating a Smart Report. An Analyst may be viewed by highlighting it and selecting it with input device **21**. An Analyst Builder window **130** (FIG. **7**) appears containing the preselected settings saved within the Analyst and used to generate the corresponding Smart Report listed in display area **102**. (The Smart Reports listed in display area **102** are arranged in the same order as the Analysts listed in display area **104**, and have the same titles as the corresponding Analysts). The Analyst Builder window **130** may be not be maximized, resized, or minimized as an icon; it may only be closed in a manner well known to users of the WINDOWS 3.1 operating system and other windows operating environments.

Buttons **110–122** (FIG. **6**) implement the primary operational commands within pull-down menus **106** and are activated using a pointing device. Button **110** calls the Analyst Builder window **130** (FIG. **7**).

Button **112** calls a Segments divider within a Business Information Setup window **132** (FIG. **8**).

Button **114** calls a Schedule window **134** (FIG. **11**).

Button **116** deletes a selected file or folder within display areas **100–104**.

Button **118** creates a new folder.

Button **120** calls the Analysis window **136** with a selected Smart Report from display area **102**.

Button **124** closes client subsystem **12**.

Button **126** (FIG. **12**) closes the Analysis window **136**.

Button **128** (FIG. **12**) causes a previous Smart Report to be displayed.

With reference to FIG. **7**, Analyst Builder window **130** allows a user to define how selected data is analyzed. An Analyst is named under the Analyst Name field. A type of analysis is chosen under the Type of Analysis field. A primary measure to be used in implementing the analysis is chosen under the Primary Measure field. Segments to be reported on are chosen from the list of Defined Segments.

Finally, a period for the Smart Report is defined under the Time Slice Considered fields. A Smart Report can be created immediately by selecting the Report Now button, or can be scheduled as part of a batch of Smart Reports by selecting the Schedule Analyst button.

With reference to FIG. 8, the Segments divider within the Business Information Setup window 132 allows Segments to be created, modified, or deleted. A description of the segment appears in the Description field.

With reference to FIG. 9, Measures of information may be created and modified within the Measures divider of the Business Information Setup window 132. A name for each Measure appears in the Measure Name field. A definition of a Measure appears in the Definition field. Mathematical operators, Time Slice constraints, Segment constraints, and constraints from other Measures may be inserted into the Definition using the corresponding buttons below the Definition field.

With reference to FIG. 10, Measure relationships may be defined and modified within the Measure Relations divider of the Business Information Setup window 132. Measure relationships are defined in terms of an if-then statement. A primary measure and whether it increases or decreases is selected in the Measure field, which represents the "If" part of the If-Then statement. Measures within the Unrelated field may be moved to either the Decreases field or the Increases field to form the "Then" part of the If-Then statement.

With reference to FIG. 11, production of Smart Reports and Alerts may be scheduled using the Schedule window 134. A batch of Smart Reports may be individually scheduled for automatic production. Scheduling of Smart Reports is particularly useful to those users that require periodic Smart Reports. Smart Report time intervals may be selected under the Time Interval field, which provides daily, weekly, and monthly reporting options.

With reference to FIG. 12, a sample Smart Report is shown within Analysis window 136. The type of analysis performed is indicated in the Smart Report and in the title bar as "Change Analysis". The Segment (previously defined within the Segments divider of the Business Information Setup window 132) is "Store Ages Greater than 3 Years". The Measure (previously define within the Measures divider of the Business Information Setup window 132) is "Same Store Sales". The Time Slice (previously defined in the Time Slice Considered fields of the Analyst Builder window 130) is "Year to date 1995 vs. Last Year".

The Smart Report provides a concise statement of changes that have occurred in the Primary Measure, Same Store Sales, and changes that have occurred in Measures related to the Same Store Sales, Stores Remodeled, and previously defined within the Measure Relations divider of the Business Information Setup window 132. The Smart Report then contains an explanation, including a graph, for the change in the Primary Measure, Same Store Sales.

Smart Report may include multiple instances of HTML associated with a Measure, representing hyperlinks to text data or graphic data representing the results of the Measure.

Turning now to FIG. 13, a method for creating metadata 25 using client subsystem 12 is illustrated beginning with START 140.

In step 141, the user specifies a Business Concept.

In step 142, the user specifies one or more attributes for the Business Concept.

In step 144, client subsystem 12 provides the user with the list of columns of tables in data warehouse 24.

In step 146, the user maps every attribute to a column. The user can provide a textual description of the business concepts and the attributes.

In step 148, the user specifies one or more Business indicators by "mapping" a Business Indicator to a column in a table within data warehouse 24.

In step 150, client subsystem 12 provides the user with a list of columns for the purpose of mapping Business Indicators as well.

In step 152, user selects an "aggregate method" for the Business Indicator that is mapped, which specifies how values for the Business Indicator are aggregated. The system supports the following aggregate methods:

Add
Average
Min
Max
Count
Last in period
First in period

In step 154, the user selects the unit of measurement, and specifies whether the Business Indicator is a currency. The user can optionally specify a plural form of the Business Indicator, a verb to describe change in the value of the Business Indicator, the precision for reporting the Business Indicator and a textual description of the Business Indicator.

In step 156, client subsystem 12 ensures that tables having Business Indicator columns can be joined with tables that have Business Attribute columns.

In step 158, client subsystem 12 determines whether the user wishes to enter additional Business Concepts. If so, the method returns to step 142. If not, the method ends at step 160.

Although the present invention has been described with particular reference to certain preferred embodiments thereof, variations and modifications of the present invention can be effected within the spirit and scope of the following claims.

What is claimed is:

1. A system for generating a report for a user regarding an enterprise of the user, comprising:

a first computer which executes an application program which allows the user to create data types, to create and constrain relationships between the data types, and to select and define an analyst representing a method of analysis to use in generating the report, wherein the analyst selects and retrieves dimensional queries and executes the dimensional queries to retrieve data within the data types to generate the report;

a database containing the data; and

a second computer coupled between the first computer and the second computer which executes a database management program including

a first subsystem for translating user requests for the data, for generating the dimensional queries for retrieving the data from the database, and for processing user modifications to the data types used in generating the report;

a second subsystem coupled to the first subsystem which reads the data from the database, creates the data types, creates a mapping of the data types to the data, uses the mapping to translate the dimensional queries received from the first subsystem into Structured Query Language (SQL), and returns query results to the first subsystem; and

a third subsystem for automatically running the analyst at predetermined times and for causing alerts to be displayed when the data satisfies user-selected alert conditions.

2. A system for generating a report for a user regarding an enterprise of the user, comprising:

a client computer which executes an application program including

a graphical user interface (GUI) which allows the user to select and specify parameters for the report, display the report, print the report, and save the report;

a business information setup subsystem which allows the user to create data types and create and constrain relationships between the data types; and

an analyst definition subsystem which allows the user to select an analyst representing a method of analysis to use in generating the report using the GUI, wherein the analyst selects and retrieves dimensional queries for the analyst and executes the dimensional queries to retrieve data within the data types to generate the report;

a database containing the data;

a server coupled between the client computer and the database which executes a database management program including

a first subsystem for translating user requests for the data, for generating the dimensional queries for retrieving the data from the database, and for processing user modifications to the data types used in generating the report;

a second subsystem coupled to the first subsystem which reads the data from the database, creates the data types, creates a mapping of the data types to the data, uses the mapping to translate the dimensional queries received from the first subsystem into Structured Query Language (SQL), and returns query results to the first subsystem; and

a third subsystem for automatically running the analyst at predetermined times and for causing alerts to be displayed when the data satisfies user-selected alert conditions.

3. A system for generating a report for a user regarding an enterprise of the user, comprising:

a computer which executes a database management program including

a first subsystem for translating user requests for data from a database, for generating user-initiated dimensional queries for retrieving the data from the database, and for processing user modifications to data types used in generating the report;

a second subsystem coupled to the first subsystem which reads the data from the database, creates the data types, creates a mapping of the data types to the data, uses the mapping to translate the user-initiated dimensional queries received from the first subsystem into Structured Query Language (SQL), and returns query results to the first subsystem; and

a third subsystem for automatically running the analyst at predetermined times and for causing alerts to be displayed when the data satisfies user-selected alert conditions.

4. A method of generating a report for a user regarding an enterprise of the user, comprising the step of:

storing data related to the enterprise as metadata in a data warehouse;

creating and modifying data types by a first computer coupled to the data warehouse in response to first user selections recorded by an application program executed by a second computer coupled to the first computer;

creating a mapping of the data types to the metadata by the first computer;

creating an analyst from predetermined business segments and measures by the application program;

saving the analyst for future analysis of the metadata by the application program;

recording a schedule of a number of user-selected times for the analyst to run by the application program;

recording a user-selected alert condition by the application program;

selecting dimensional queries for retrieving metadata from the data warehouse by the analyst in response to receipt of any one of a number of commands including a command from the user to run the analyst by the application program, and receipt of a command from the first computer to automatically run the analyst at one of the user-selected times;

translating the dimensional queries into Structured Query Language (SQL) using the mappings by the first computer;

obtaining a portion of the metadata from the data warehouse in satisfaction of the dimensional queries by the first computer;

returning the portion of the metadata to the application program;

displaying the metadata in a user-selected format by the application program;

determining from the portion of the metadata whether the alert condition is satisfied by the application program; and

displaying an alert by the second computer if the alert condition is satisfied.

* * * * *